Journal of Pharmacognosy and Phytochemistry

Available online at www.phytojournal.com

E-ISSN: 2278-4136
P-ISSN: 2349-8234
www.phytojournal.com
JPP 2020; 9(4): 772-775
Received: 13-05-2020
Accepted: 15-06-2020

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Optimisation of osmotic dehydration process for aonla (*Emblica officinalis*) fruit in the mixture of salt-sugar solution

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DOI: https://doi.org/10.22271/phyto.2020.v9.i4k.11794

Abstract

The osmotic dehydration of aonla fruit was carried out to optimize the time of the osmosis in the mixed solution of sugar and salt at the room temperature. The destined aonla fruits with and without blanching were immersed in the mixture of salt and sugar solution. The salt concentration of the osmotic solution was kept constant (100 g) and the sugar concentrations were varied to bring the concentrations to 35, 45 and 55° Brix maintaining a fruit to syrup ratio of 1:3 by weight. The observations were recorded to study the influence of osmotic solution and time on water loss and solid gain. The results of osmotic dehydration showed the maximum water loss of 48.55 per cent recorded for blanched fruit osmosed at 55° B and the minimum (27.61%) in unblanched fruit osmosed at 35°B. The solid gain also was observed to be maximum (23.4%) in the blanched fruit compared to unblanched fruit (9.94%) at respective concentrations. The optimization process carried out using Design expert software showed the highest desirability of 0.785 for blanched aonla fruit osmosed at 55 °B.

Keywords: Aonla dehydration, osmotic dehydration of aonla, aonla osmosis

Introduction

Aonla (*Phyllanthus emblica or Emblica officinalis*) also known as Indian gooseberry is an important fruit crop of India considered as "*Wonder fruit for health*" because of its unique qualities. It is rich source of ascorbic acid (Vit. C) and tannins (Goyal *et al*. 2008) [8]. This indigenous fruit has extensive adoptability to grow in diverse climatic and soil conditions (Sumitha *et al*., 2013) [17]. The area under amla (Indian gooseberry) has been expanding rapidly in the last couple of years. The total area under amla is estimated to be 93,000 ha with a production of 10.75 lakh tonnes for the year 2017-18 (Horticultural Statistics at a Glance 2018) [9]. Aonla fruits are astringent, cooling anodine, carminative, digestive, stomechic, laxatic, altrant, aphordisac, diuretic antipyretic, and trichogenous (Ganachari *et al*., 2008). Aonla fruits are used in traditional Indian system of medicines, like ayurvedic and unani, due to its therapeutic values (Agarwal and Chopra, 2004) [1]. Like many other herbs, amla has been useful in curing many diseases like, diabetes, asthma, bronchitis, skin diseases, jaundice, scurvy and greyness of hair (Ganachari *et al*., 2010). In view of its therapeutic properties, there is a great demand for the amla fruit.

Aonla fruit is available only for a short period (October to January) and is highly perishable in nature (Goyal *et al*. 2008; Sumitha *et al*., 2013) [8, 17], and it is not consumed as fresh fruit due to its high acidic and astringent taste (Goyal *et al* 2007) [7]. Hence processing and storage of aonla is essential (Ganachari *et al*., 2008) [6]. Although many processing techniques can be employed to preserve the aonla fruits, drying is one of the important operations that is widely being practiced. There have been many advances in recent and past, for development of new dehydration technology that resulted in the production of enormous convenience and ready to eat products, which not only meet quality but also provide sufficient stability and economy. In all these processes, the food materials undergo phases of high temperature and time combinations. These significant high temperature processing would impair fresh quality of the food and hence result in the products without original flavour, colour and textural attributes after rehydration (Alam *et al*. 2017). In such cases osmotic dehydration is challenging technique which can preserve these qualities to some extent (Shi and Maguer, 2002). Osmotic dehydration is one of the best techniques to lower the water activity of the foods, where the integrity of the product is kept unaffected, by soaking the slices of the fresh fruit in an appropriate solution to result the final product having desired water activity (Alam and Singh, 2010) [3].

Osmotic dehydration has also been found quite suitable pre-processing tool where foods are dehydrated partially followed by the conventional drying process. During subsequent drying process the product is exposed to shorter time and temperature combination there by not only preserving the fresh like status of the fruit, but also aid in significant reduction in the energy requirements. Further, in recent years, minimal processing of the food and development of ready to eat or convenience food for human consumption has received considerable attention that has given impetus attention to the application of the osmotic dehydration. This technology is applied to the aonla fruit with the intention to store the fruit with development of the new minimally processed ready to eat osmotically dehydrated product. Hence, the optimisation of osmotic dehydration process for aonla fruit in salt and sugar solution was carried out to optimize the osmotic process parameters (concentration of solution, blanching treatment and process time) on quality responses (water loss and solute gain).

Materials and Methods

Preparation of samples

Aonla fruits (*Emblica officinalis*) of *Chakia* variety were procured from the farmer of Ketanur village in Coimbatore district since it is suitable for the dehydration and candy making **(**Pragati *et al.*2003) [12]. Ripe fruits having almost similar size and colour were chosen; washed with portable water to remove any extraneous matter adhering to the fruits. The fruits were then deseeded using the hand operated destoner developed by TNAU Coimbatore (Ganachari *et al*. 2008) [6]. The deseeded fruits were used for osmotic dehydration with and without blanching (dipping in boiling water for 5 min) treatment to observe the effect.

Preparation of osmotic solution

The osmotic dehydration of aonla was carried out in the mixed solution of sugar and salt since the fruit is being used as fruit as well as vegetable. The salt concentration of the osmotic solution was kept constant and the sugar concentration was varied (35, 45 and 55ºB). For the preparation of syrup 100 g each of salt and 250, 350, and 450 g of sugar were dissolved in to 650, 550 and 450 g of water respectively in 1000ml glass containers. Stirring and heating was done with ladle to dissolve the salt and sugar completely. The syrup was filtered using a muslin cloth and its strength was checked using refractometer.

Osmotic dehydration Aonla fruits

The osmotic dehydration of deseeded aonla fruit was carried out for unblanched and blanched fruits by dipping in the sugar-salt syrup concentrations of 35, 45 and 55 ºB. Approximately 300 g of the fruits were weighed and dipped in the syrup maintaining a fruit to syrup ratio of 1:3 by weight at room temperature. To enhance the shelf life and to protect the fruits from microbial attack, potassium sorbate was added as preservative to the solution at 220 ppm. The weight of the fruit was recorded after draining and blotting of adhering syrup for every four-hour interval, since it is a hardy fruit which takes more time to remove moisture. The fruits were dried at 60 °C temperature using hot air tray dryer and packed in HDPE pouches of 200 gauge (Saxena *et al*. 2017) [15] to retain quality characteristics.

Water loss and solute gain during osmotic dehydration

The mass transfer parameters i.e water loss (WL) and solid gain (SG) reflecting as one of the quality attributes of aonla were calculated by the equations given by Aktas *et al*. (2007) [2].

$$\text{Weight reduction (WR) in (\%)} = \left(\frac{InitialFruitweight - FinalFruitweight}{InitialFruitweight}\right) X100$$

$$\text{Solid gain (SG) in (\%)} = \left(\frac{Totaklsolids - Initialsolids}{InitialFruitweight}\right) X\ 100$$

$$\text{Water loss in (\%)} = (WR + SG)$$

Optimization of osmotic process parameters

General factorial analysis was applied to the experimental data using a statistical package, Design-Expert version 7.0.0 (Statease Inc., Minneapolis, USA, Trial version). The osmotic process variables selected for the study were blanching treatment, concentration of osmotic solution and immersion time. The blanched and unblanched aonla fruits were immersed in osmotic solution concentrations of 35, 45 and 55ºB and the immersion time was upto 16 h at an interval of 4 h. The optimization of the osmotic dehydration process aimed at finding the effect of independent variables on water loss (WL) and solute gain (SG).

Results and discussion

The osmosis of aonla fruits was carried out to determine the suitability of blanching treatment and the concentration of the osmotic medium on water loss and solid gain. The water loss increased with increase in osmosis time while the rate of water loss decreased, at all the concentrations. It was observed that more water loss was observed at a time interval of 16 h, after this time the water loss was very less which was found to be non-significant. This might be due to reduction in the osmotic pressure caused by dilution of the solution and similar results were reported by Ravindran (1987) [14] for pineapple.

Effect of blanching treatment on water loss and solid gain

The effect of blanching treatment on water loss and solid gain in aonla fruit at three different concentrations is shown in Fig.1. The data analyzed statistically showed the blanching treatment increased the osmosis, water loss and solid gain. The water loss was observed to be maximum in the blanched fruits (48.55%) as compared to unblanched (40.21%) at same concentration. Blanching also was found to have significant effect on the solid gain. Similar to water loss, the solid uptake was observed to be higher as compared to unblanched fruits at all concentrations. Solid gain was noticed to be maximum when blanched fruit was osmosed in 55^0 B while it was minimum in unblanched 35^0 B treatments. This might be due to removal of the natural wax coating present around the fruit during blanching by heat and softening of the tissues which allows the solids entry and water loss. Similar results were also observed by Alam and Singh (2010) [3] for aonla fruits.

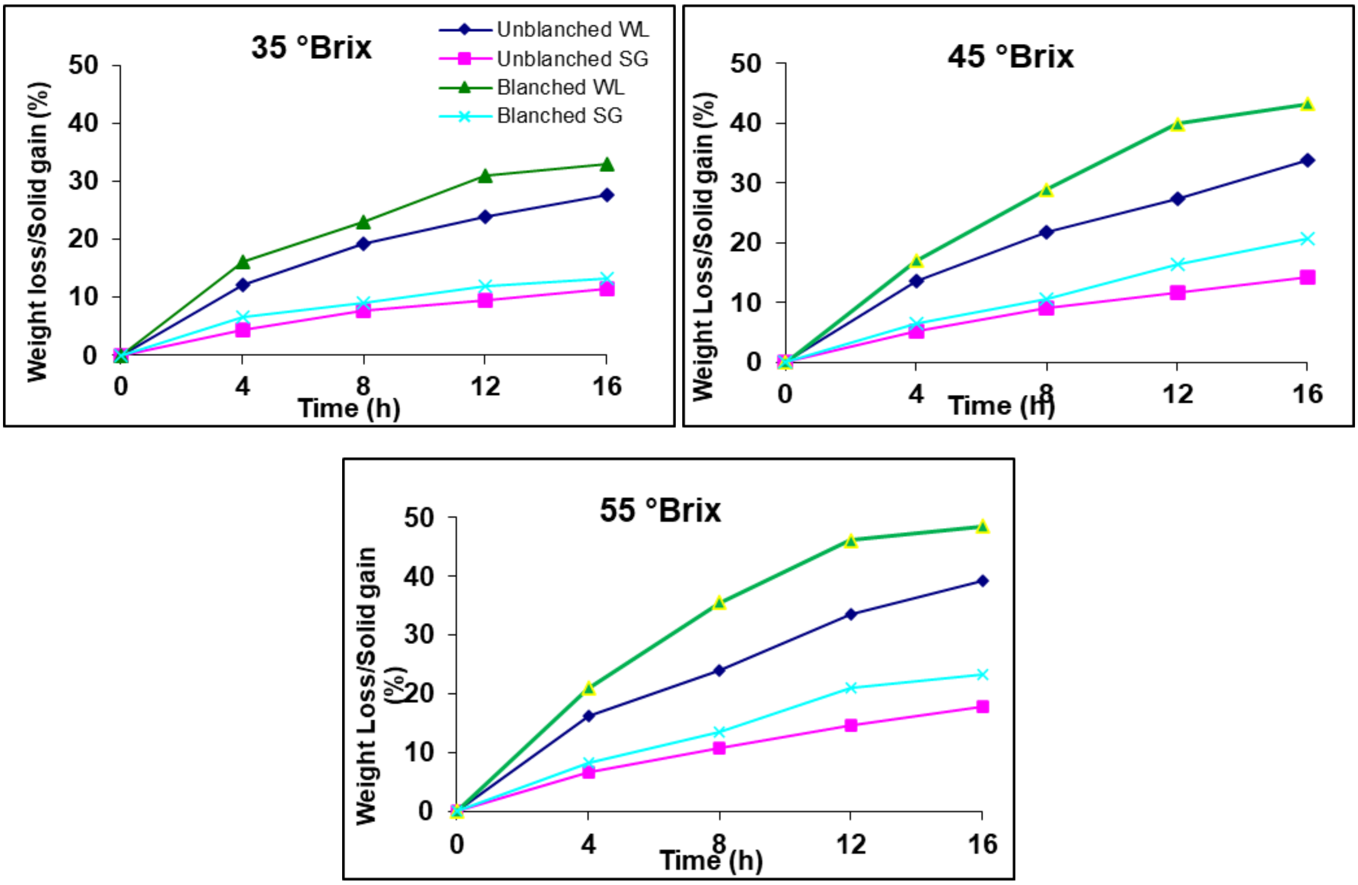

Fig 1: Effect of blanching on water loss and solid gain of aonla fruits at different concentrations of osmotic solution

Effect of concentration on water loss and solid gain
The effect of concentration on water loss and solid gain in aonla fruit at three different concentrations is shown in Fig.1. The statistical analysis of data showed that water loss and solid uptake have significant effect on concentration of the osmotic solution. The maximum water loss and solid gain were observed at 55^0 B concentration, compared to other two concentrations. This higher concentration promoted the increase in water loss and solid gain during the process could be due to the increase of osmotic pressure outside the fruit (Mizkahi *et al*. 2001; Mundada *et al*. 2010) [10, 11]. This was consistent with the investigations reported by Prinzivalli *et al*. (2007) [3] for strawberry and Alam and Singh (2010) [3] for aonla fruits.

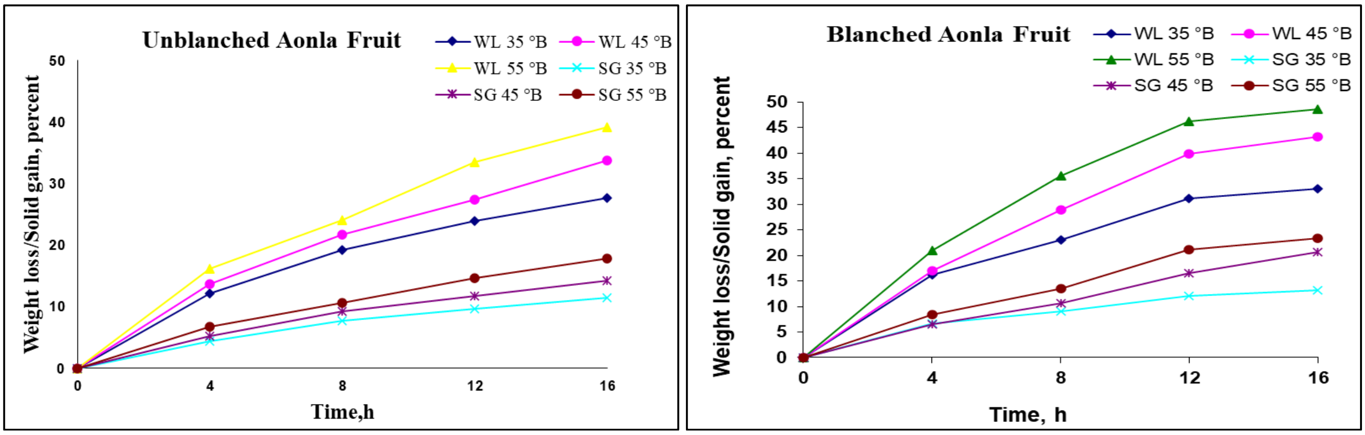

Fig 2: Effect of concentration on water loss and solid gain in aonla fruits

Optimization of osmotic treatment and concentration
Numerical optimization was applied to determine the optimal osmotic treatment and concentration osmotic solution for maximizing the water loss and solid gain. Optimum points established 6 solutions, but only several points were chosen as optimum points, on condition that it satisfied the criteria mentioned. The optimimum desirability of 0.785 was obtained for blanched aonla fruit osmosed at 55 ºB.

Conclusion
It can be concluded based on the above outcome that, osmotic concentration and blanching treatment were the significant factors that affected the water loss and solid gain during osmotic dehydration of aonla fruits. The aonla fruits can be osmotically dehydrated by dipping the blanched aonla fruits in the mixture of salt-sugar solution at 55ºB for 16 h followed by drying in tray dryer and packed in HDPE pouches.

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